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Summer Observations of Air Temperature and Relative Humidity Inside and Outside a Broiler House.

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SUMMARY

Continuous recordings of air temperature and relative humidity (RH) were made inside and outside a commercial broiler house near Hereford for several periods between January and August 1983. There were 24,400 birds in the house investigated giving a stocking density of 24.3 birds per metre². Ventilation was by 16 fans (24"), each moving 5,500 ft³ of air per minute (9300 m³ per hour). During the last week of a summer crop 150 birds died in the house being monitored and 1,000 died on the unit as a whole. The conditions found inside the house are discussed with particular regard to the influence of ambient weather. It is concluded that the hot, humid and thundery weather just preceding the deaths was a final triggering event after about 2 weeks of warm weather producing gradually increasing stress.

INTRODUCTION

The feed conversion ratio (FCR) - the ratio of bodyweight gained to feed intake - decreases, ie improves, with increasing temperature but because body weight declines quadratically as temperature increases above about 21°C, the "profitability" maximises at about 20 to 23°C, (Charles et al, 1981). The chief detrimental effect of high temperatures, greater than 23°C, is the heat-stress which in extreme cases can cause large numbers of deaths in mature broilers at the normal commercial stocking density. (Cochrane, 1984). There is a lack of published data on broiler deaths associated with very warm or humid ambient weather conditions and J Binstead, the ADAS National Specialist, helped set-up this investigation through his contacts with commercial firms.

In hot summer weather, the outside air temperature may be above 23°C for several

hours each day (Barrie, 1983; Cochrane 1984) and the house temperature will invariably be much warmer than this. Just how much warmer for a given stocking density and bird size will depend upon the ventilation system and its control, the design and insulation properties of the house, the persistence of hot weather over several days, and the diurnal pattern of outside air temperature and relative humidity (RH). The last 3 factors, all environmental, were evaluated for a typical commercial broiler house in the summer of 1983. This paper describes a long sequence of weather conditions which culminated in a large number of birds dying near the final stages of production.

THE SYNOPTIC SITUATION JULY/AUGUST 1983

Persistently between 8 July and 21 August high pressure systems brought mostly dry, warm, sunny weather to the UK. July 1983 was itself the warmest for over 300 years (Manley 1974). Low pressure areas and frontal systems crossed the country between 15-18 July and 23-25 July.

A thundery, low pressure area drifted slowly Northwards from the Bay of Biscay and by 20 August it was centred 100 miles South of Ireland. During the 19th and 20th thunderstorms were widespread over Central and Southern England.

Electrical discharges were mostly between clouds and no heavy rainfalls were recorded in the Hereford area. Moist air gradually advected over the Midlands with water vapour contents rising from around the monthly average of $10-11 \text{ gm}^3$ to $14-16 \text{ gm}^3$ by late on the 19th with air an temperature an 20°C and RH 90%.

THE RECORDING EQUIPMENT

Hair hygrographs and bimetallic thermographs were placed on shelves 1 m above the height of the litter of wood shavings inside the broiler house. Outside the recorders were housed in a louvred screen 1.2 m above short grass. The electric fans ventilating the house caused considerable turbulent mixing of the air and the differences in recordings at 0.3 m level and 1 m above the floor were likely to be small. Therefore the recordings were representative of the environment just above the birds and litter, ie the control environment.

Given the adverse operating conditions inside the house errors of up to $\pm 1^\circ\text{C}$ may be expected of the thermograph, and $\pm 5\%$ of the hygrograph.

In general the recorders performed well with sufficient sensitivity to show, for example, the operation of the brooder units (heaters) thus adding to the confidence of the measurements.

RESULTS AND OBSERVATIONS

A. Broilers aged up to 17 days (up to 20 July)

Up to this time the conditions inside the broiler house were mostly determined by the amount of heat supplied by gas fired brooder units. See figs 3a, 3b, 3c and 4a, 4b, 4c. Ambient temperatures in excess of 25°C produced an increase internally of around 3-5°C above the thermostatically set house minimum. This minimum was initially set at 31°C but declined to 25°C by 20 July.

The diurnal variation of RH inside the house was greatly smoothed with internal values ranging from 35 to 75% whilst corresponding outside values ranged from 35 to 95%. An absolute value of the moisture content of the air is given by

$$d_v = \frac{216.7}{T_a} e$$

where d_v is the water vapour concentration gm^{-3}

e is the vapour pressure mb

T_a is the absolute temperature °K

Values for d_v were calculated every 2 hours. Fig 5a shows the internal value was 5-6 gm^{-3} greater than the ambient level during the 19th and 20th July.

The increase can be attributed to respiration plus evaporation from the litter and water troughs.

B. Broilers aged 36-42 days (8 Aug-14 Aug)

Ambient temperatures approaching 30°C (by the 14th) precluded any additional heating; see fig 1f. Maximum downwards ventilation, with the vent covers removed by day, restricted the internal temperature lift to 2°C. Leaving the vent covers open overnight resulted in cooling, but only to a temperature 5°C greater than that outside; with the covers closed the difference rose to 10°C (fig 3f).

RH levels were over 90% by night both inside and outside. During the day internal values were around 8% greater than the external. The rapid changes in RH during the early morning and late evening were more pronounced than in the previous week. The d_v values further illustrate the effects of ventilation management (fig 5b). Late on the 9th, 10th, 11th and 13th a sharp rise in d_v was noted around 20-2200 hours. Reference to fig 3f shows an immediate temperature increase of 2-3.5°C at this time. The internal d_v levels, which were 2-4 gm^{-3} higher by day, were around 7 gm^{-3} higher than the ambient by night (fig 5b). Despite the higher d_v levels, the RH remained fairly constant, reflecting the effect of the simultaneous temperature increase. Hence closing the roof vent covers by night delayed the rise in relative humidity, but at the expense of higher night time temperatures and consequently a higher temperature the following morning.

C. Broilers aged 43-49 days (15-21 August)

During the 7th week no heating was applied to the broiler house. In addition the ventilation system operated at its maximum capacity all week with the roof vent covers left fully open day and night. Thus conditions internally were extremely dependent on external values and the increases of temperature and d_v in the evening which characterised the previous week were not evident.

The thermograph trace shows prolonged warm spells with ambient day time temperatures exceeding 25°C, and on the 19th, nearly 30°C, (fig 1g).

Internal daytime temperatures were 2-4°C higher than those outside, increasing to 4-7°C higher during the night: a smaller differential than in the previous week, (fig 3g). Internal RH levels were broadly similar by night but as before somewhat higher during the day when compared to the outside levels. The graph of moisture content, fig 5c, shows the progressive increase in d_v from mid-day on the 18th to midnight on the 19th/20th as the moist air associated with the low pressure area moved northwards. By Saturday this was reflected by cloudier weather with lower ambient temperatures and much higher RH values which were generally above 80%. In the house being investigated about 150 birds died between 6.00 pm on the 19th and 8.00 am on the 20th. The accompanying thunderstorms were widespread in the vicinity of the poultry unit but no objective appraisal of their direct effect can be made. The liveweight of the broilers average 3.6lb by the 19th.

During the last days of the broiler crop the management made an additional effort to reduce the risk of mortalities over-night by periodically disturbing the birds to reduce the risk of local clustering and the consequential overheating.

CONCLUSIONS

During the 7 week lifetime of one broiler crop the weather was very warm for much of the time but only in the 7th week did a number of birds die.

The steady build-up of environmental stress was directly caused by the increasing body weight of the birds and the persistently hot weather. Thunderstorms and an increase in moisture content of the outside air during the 7th week seemed to be the events which finally triggered the death of a large number of birds.

The high values of RH found inside the house, well above the 50% reference value used by Cochrane (1984), will further increase respiratory rate and heat stress in the flock. Subsequently at high RH levels the temperature tolerance of the birds will be lower when compared to lower RH levels.

Any comments or suggestions should be referred to the authors.

Acknowledgement

The authors are indebted to Dr Mandy Hill and Dr D R Charles, ADAS poultry specialists, for their useful editorial contributions and to Mr R Taylor who helped with the preparation of the diagrams. The co-operation of the farm manager and his wife who maintained the recordings on the farm is appreciated.

References

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- Cochrane J 1984 Heat stress in broiler chickens. Agricultural Memorandum No. 1013.
- Charles D.R., Groom C.M., Bray T.S., 1981. The effects of temperature on Broilers: Interactions between temperature and the feeding regime. British Poultry Science, 22, pp 475-481.

MET. UNIT

MAFF

Woodthorne

Wolverhampton

December 1984

Fig 1a

AMBIENT TEMPERATURES.

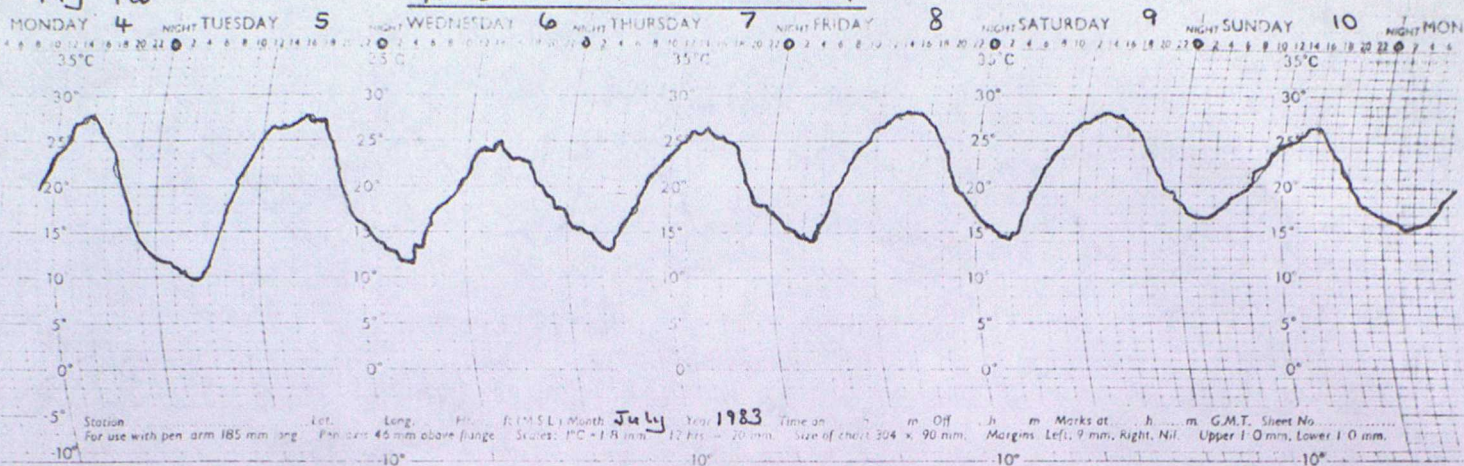


Fig 1b.

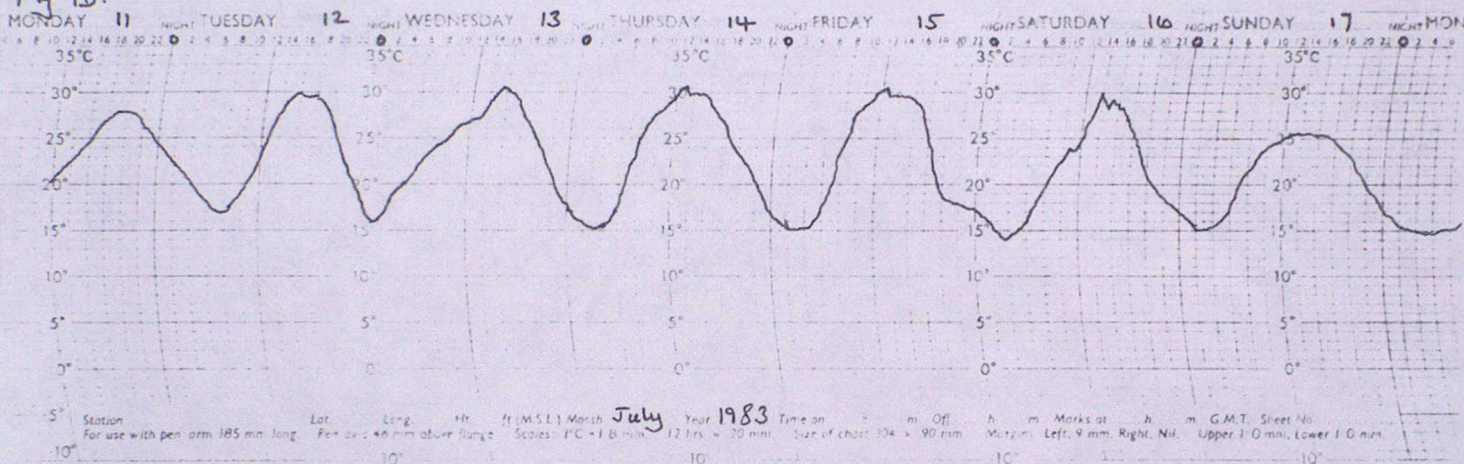


Fig 1c

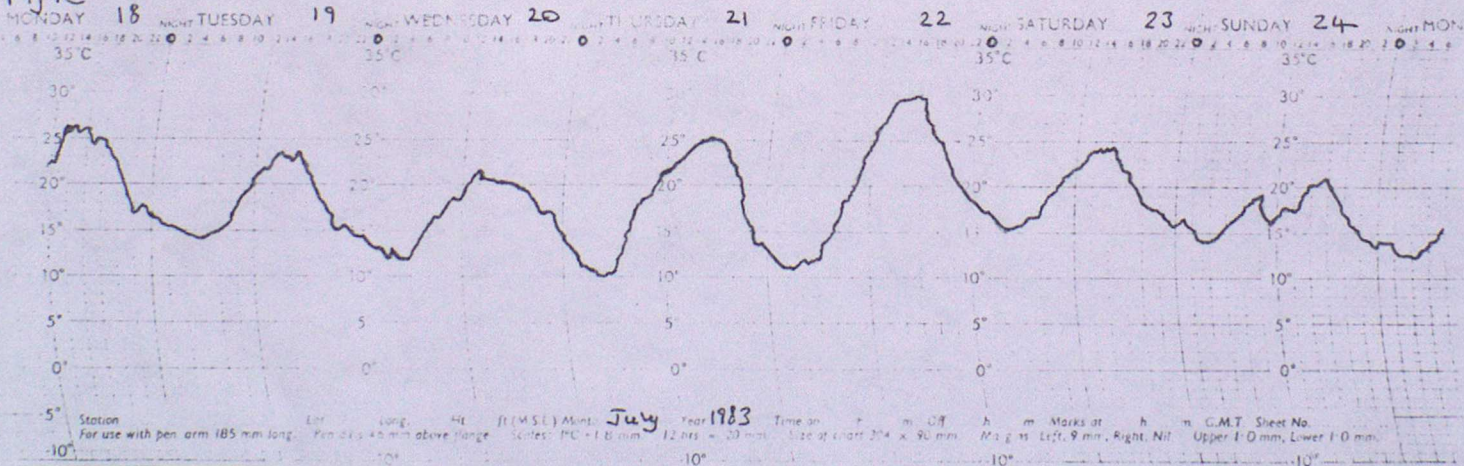


Fig 1d

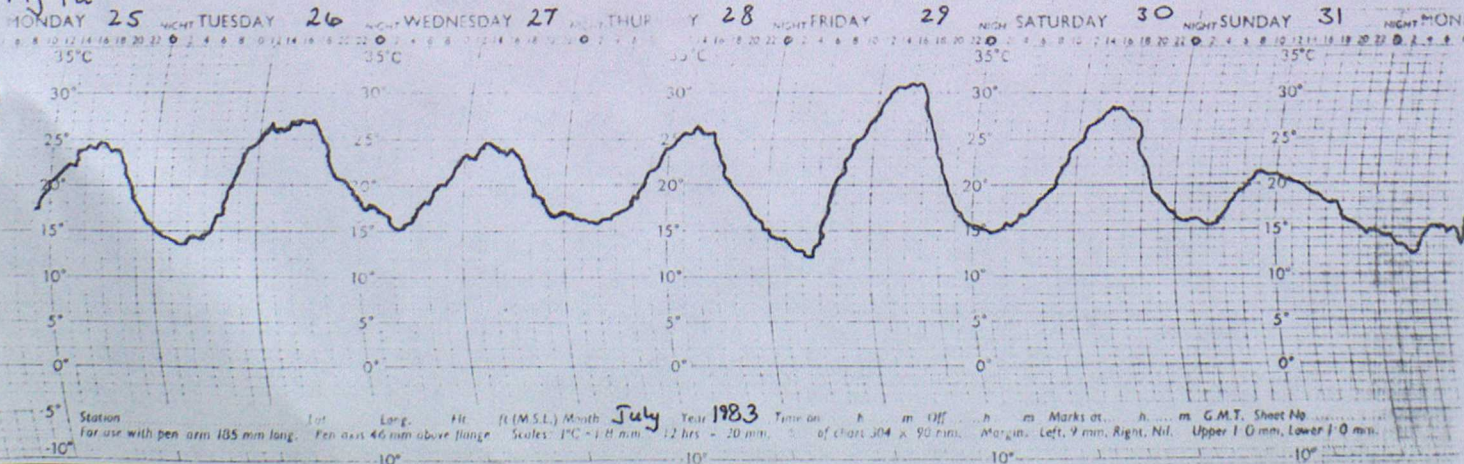


Fig. 1 e

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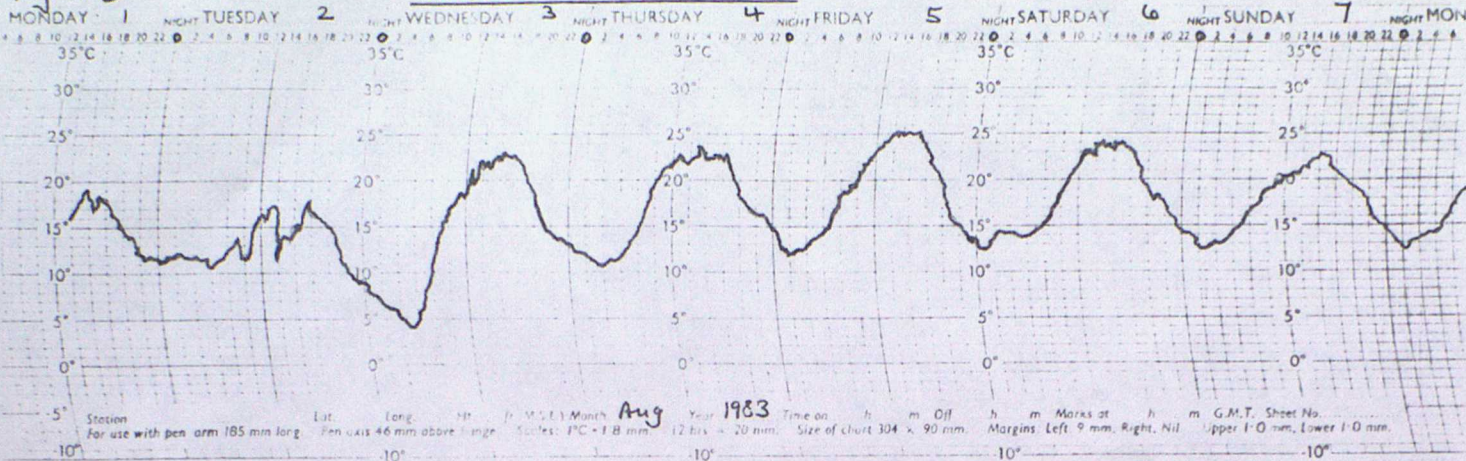


Fig. 1 f

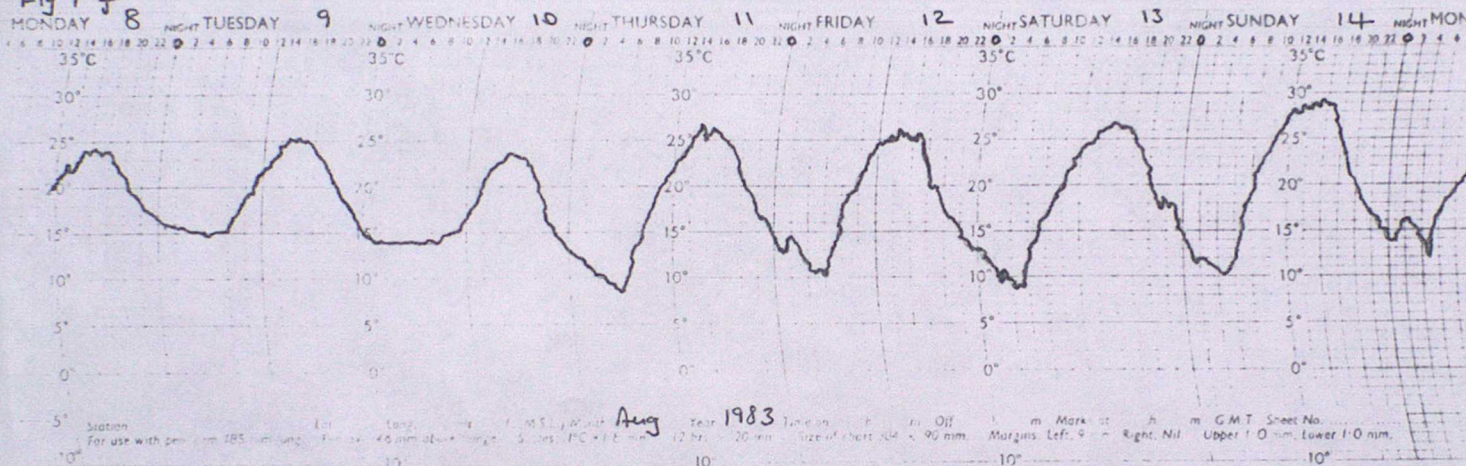


Fig. 1 g.

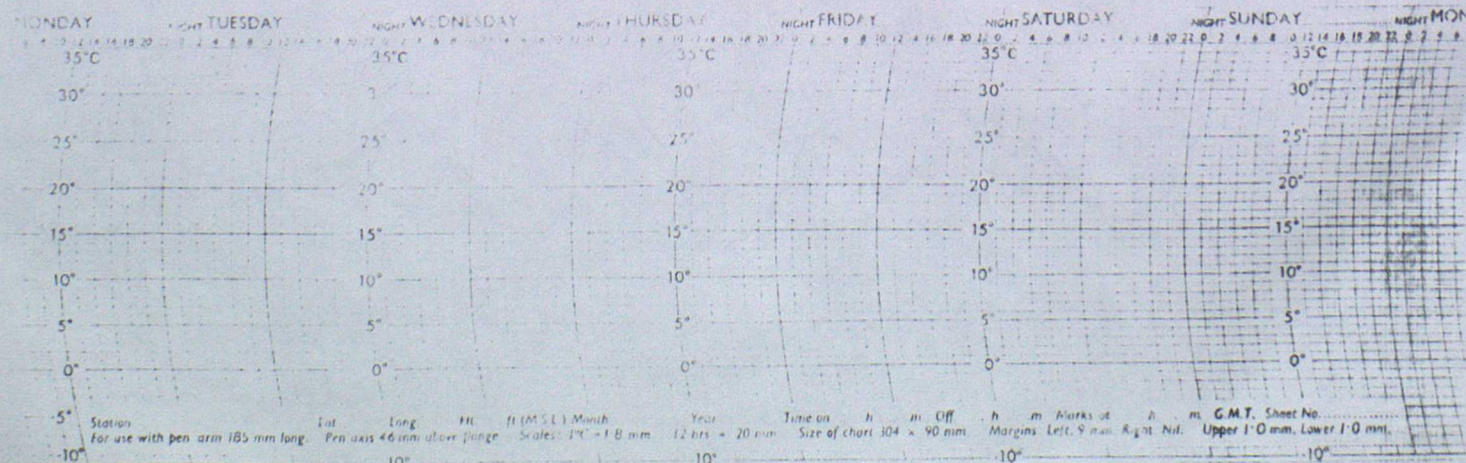
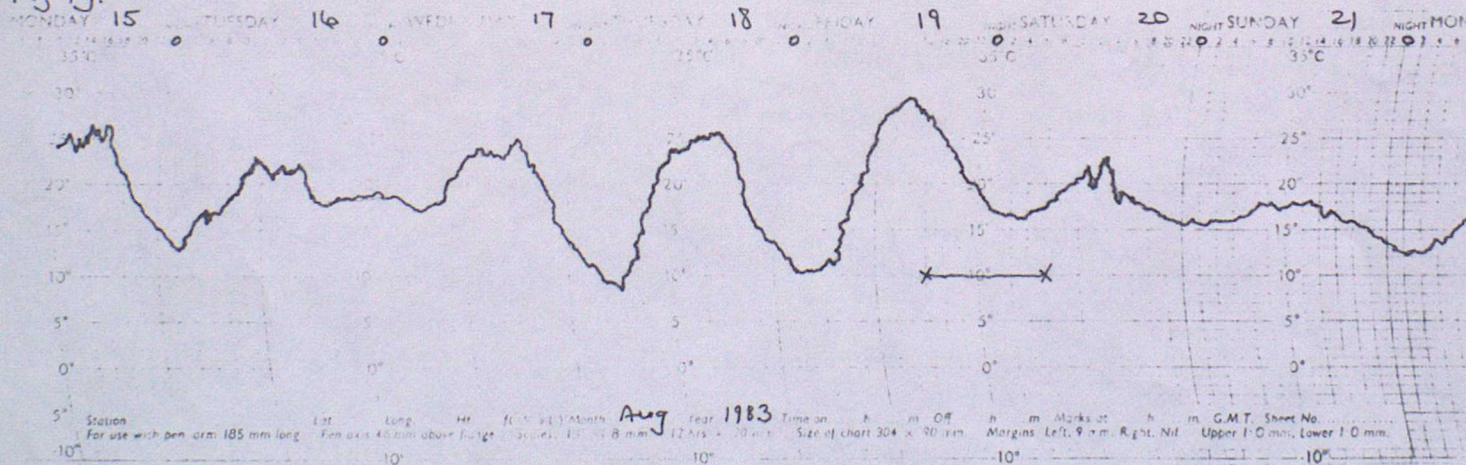


Fig 2a

AMBIENT RELATIVE HUMIDITY

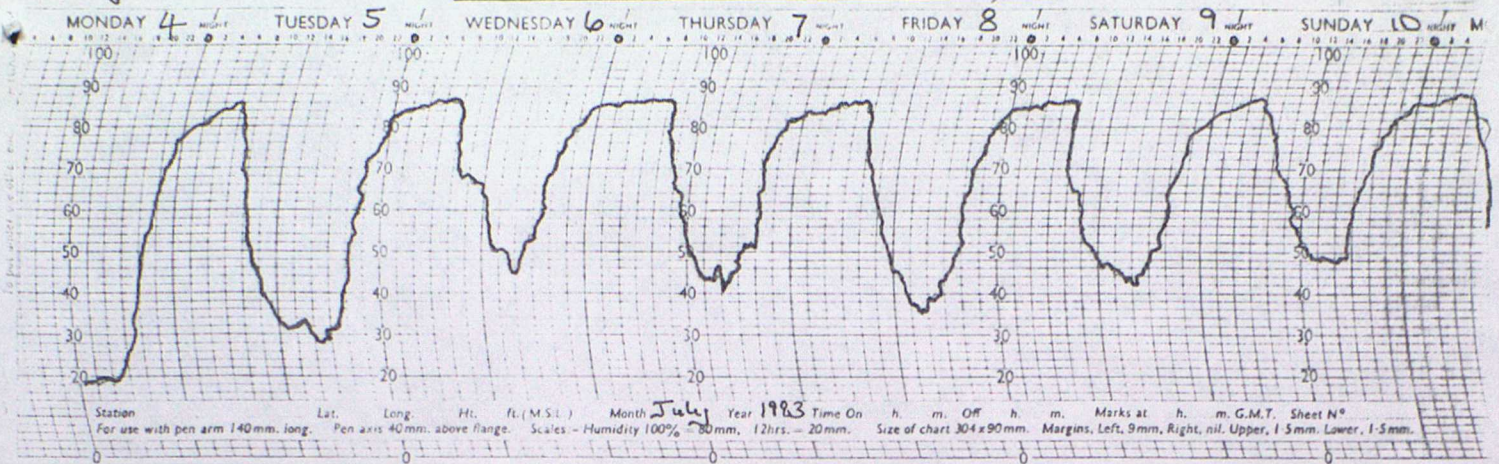


Fig 2b

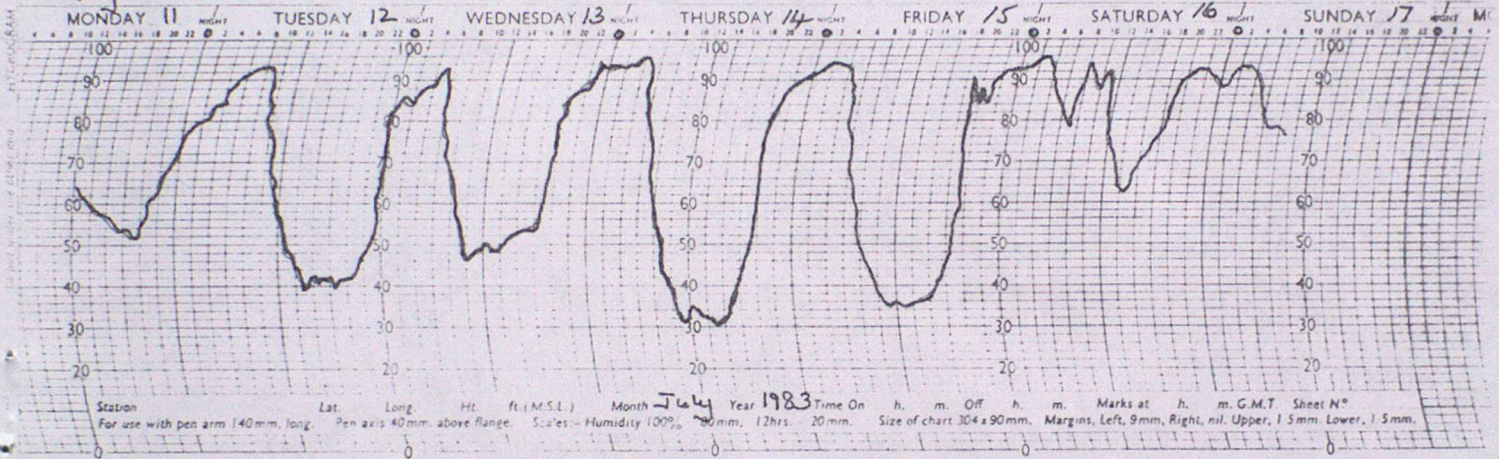


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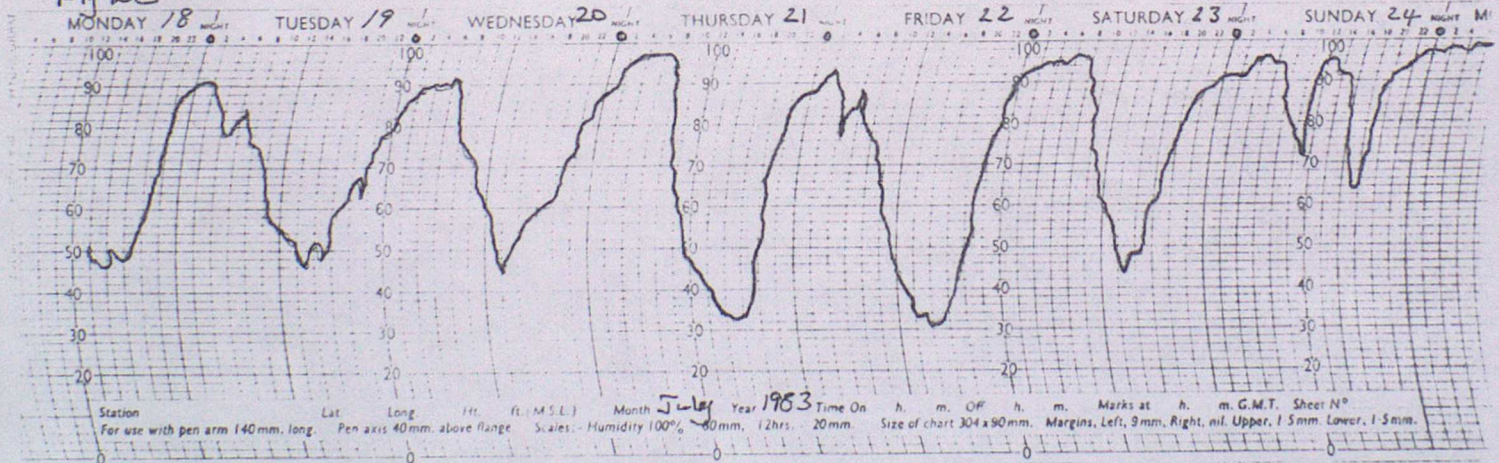


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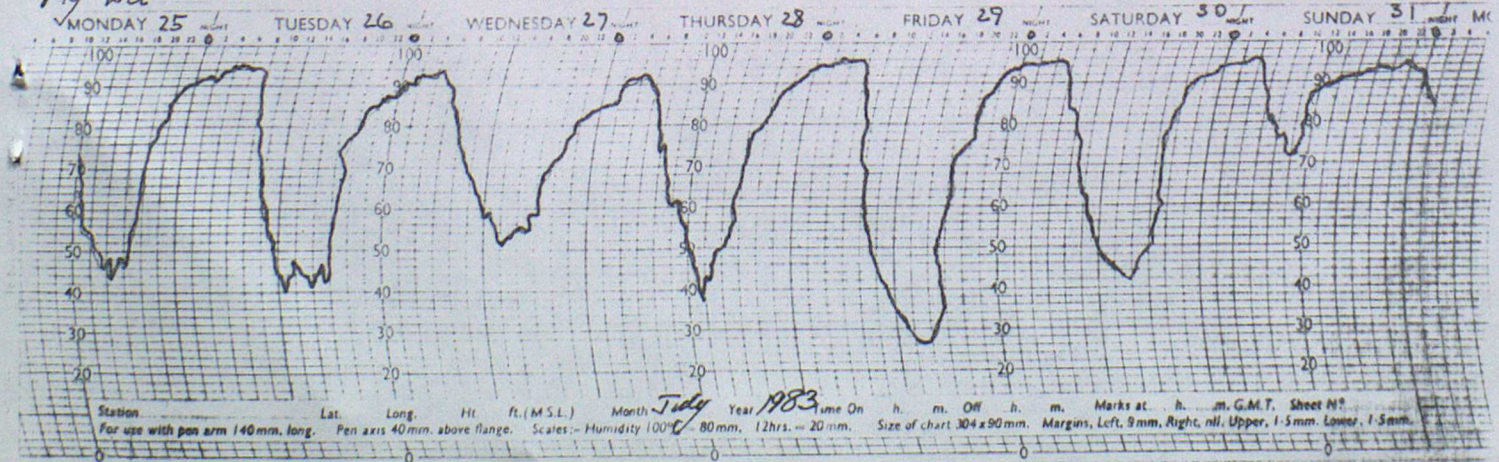


Fig 2 e

AMBIENT RELATIVE HUMIDITY

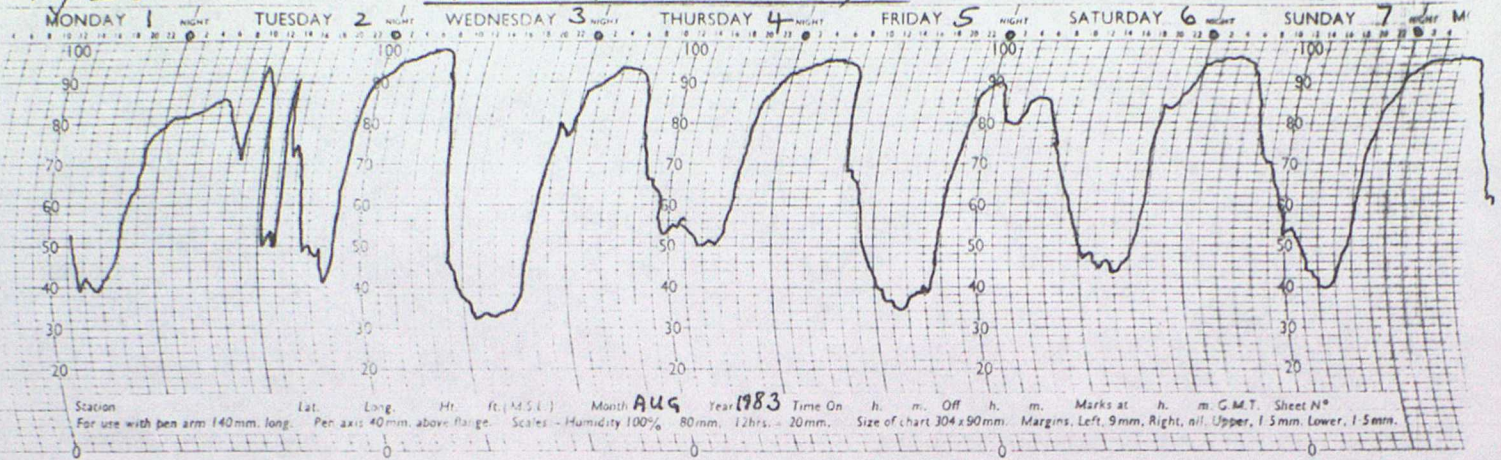


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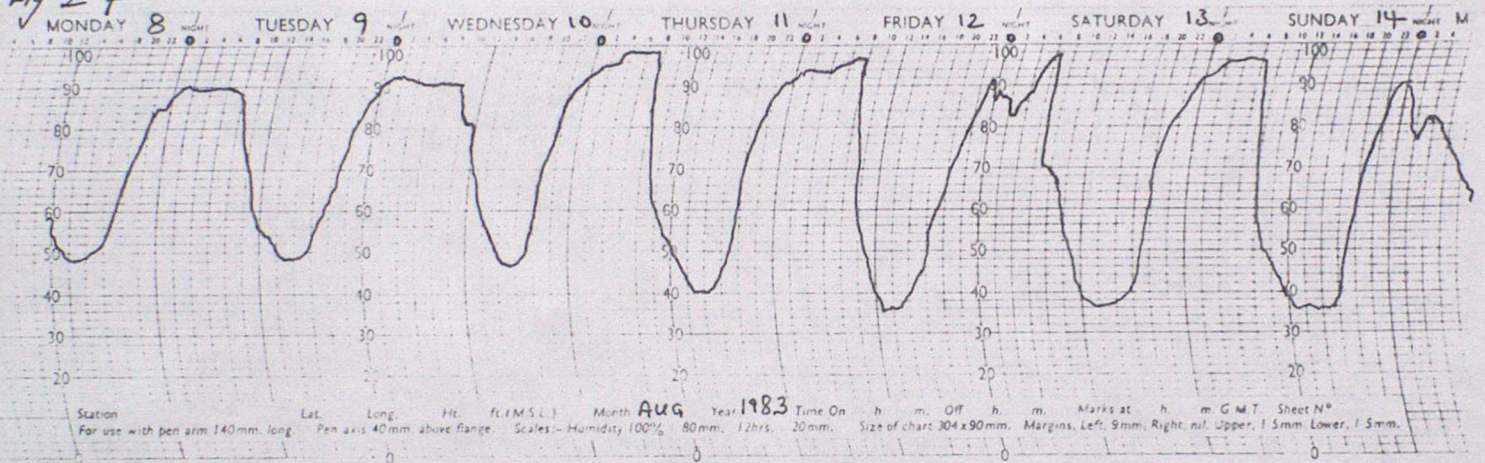


Fig 2 g

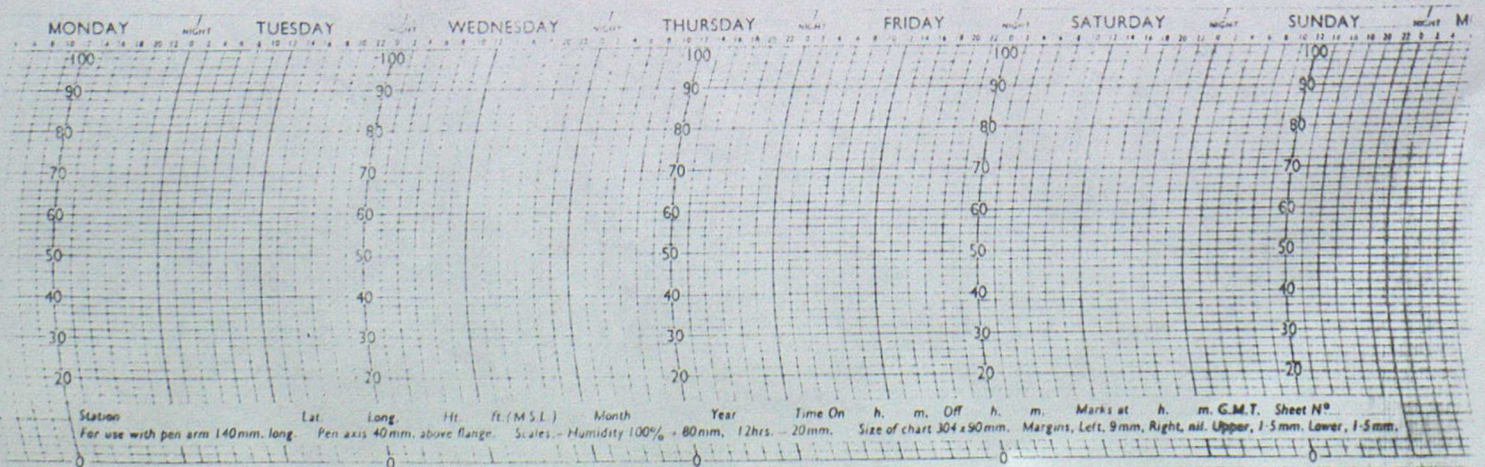
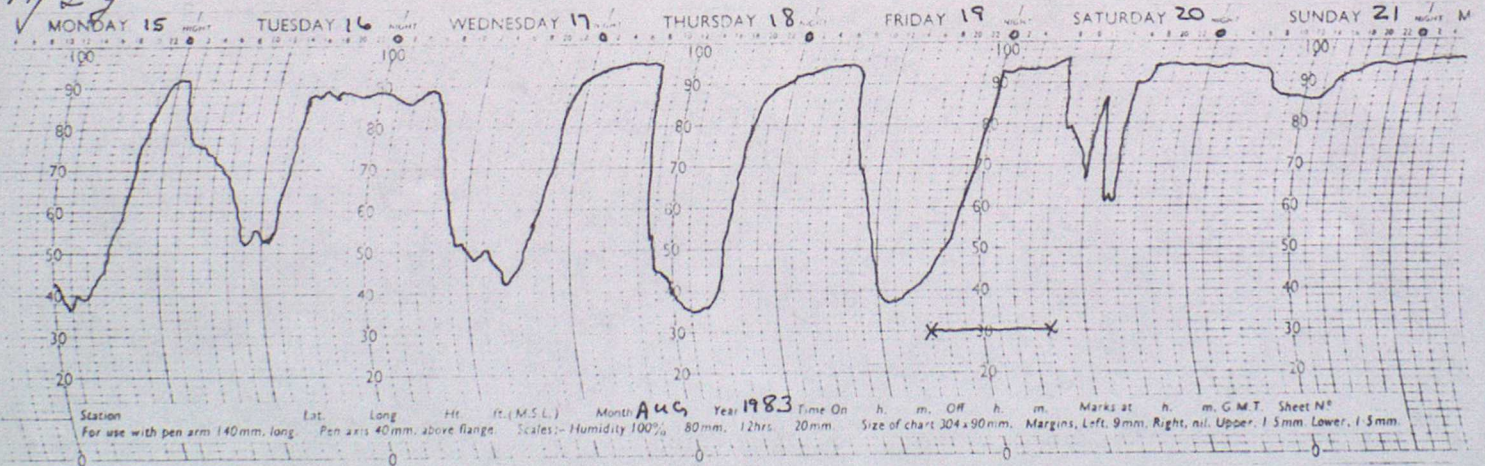


Fig 3a

INTERNAL TEMPERATURE.

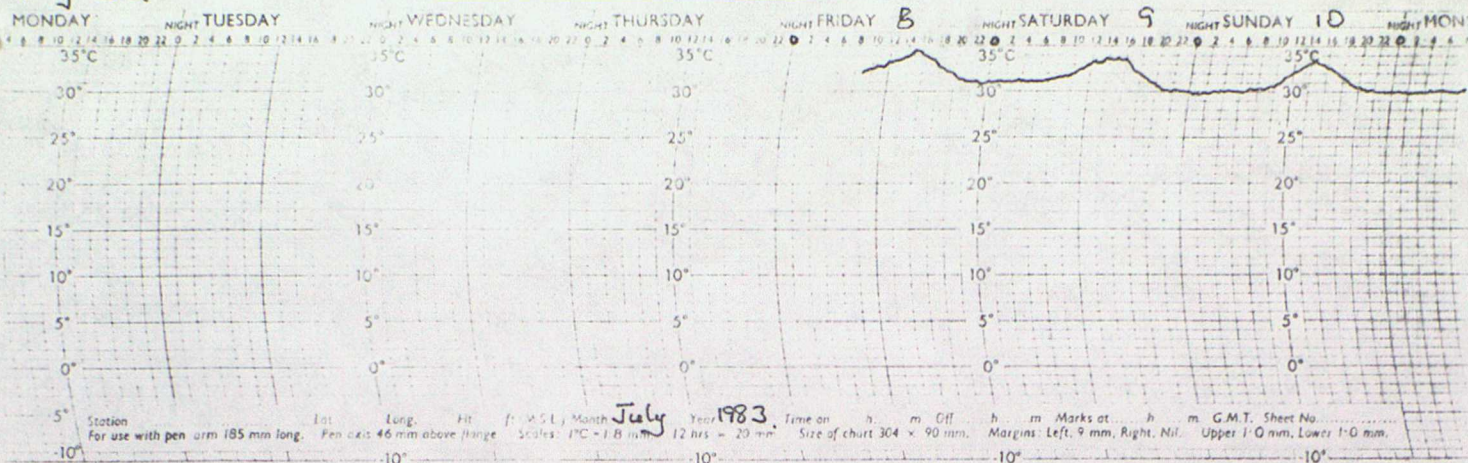


Fig 3b

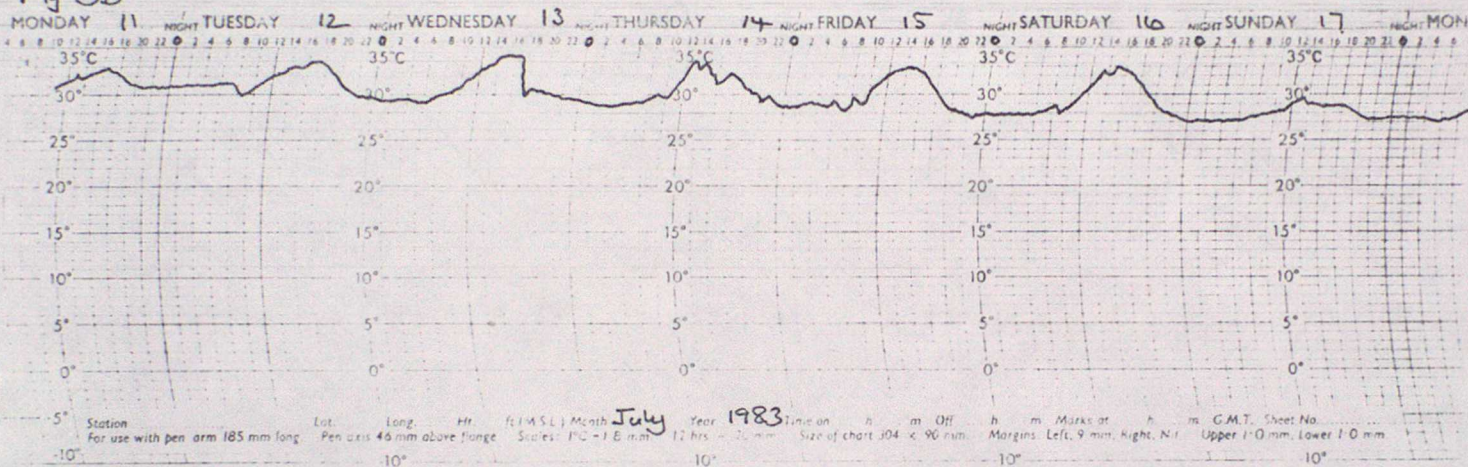


Fig 3c

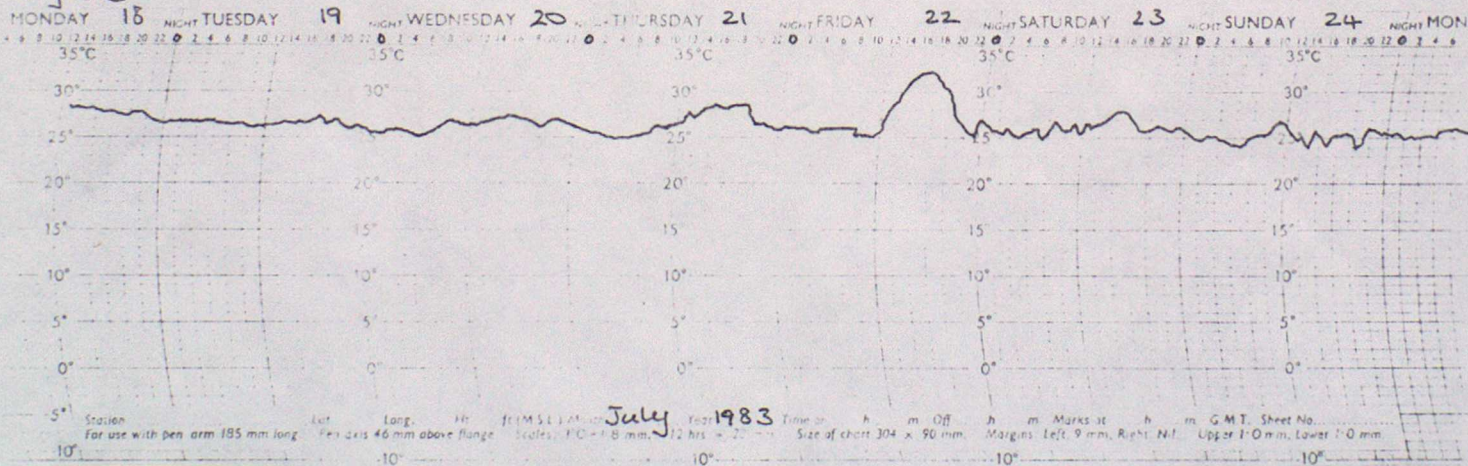


Fig 3d

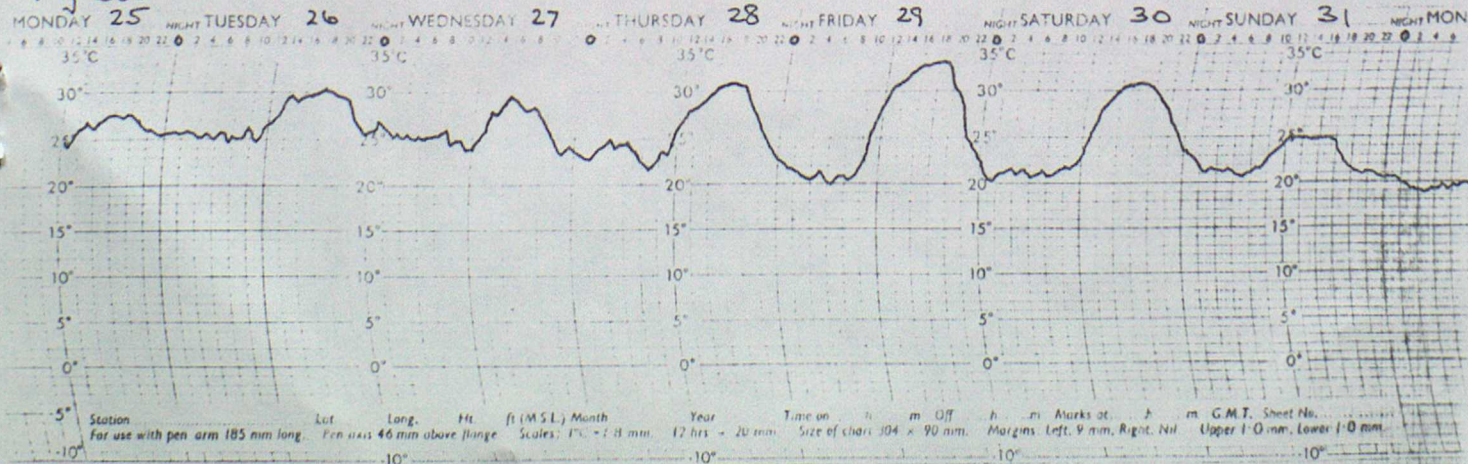


Fig 3e

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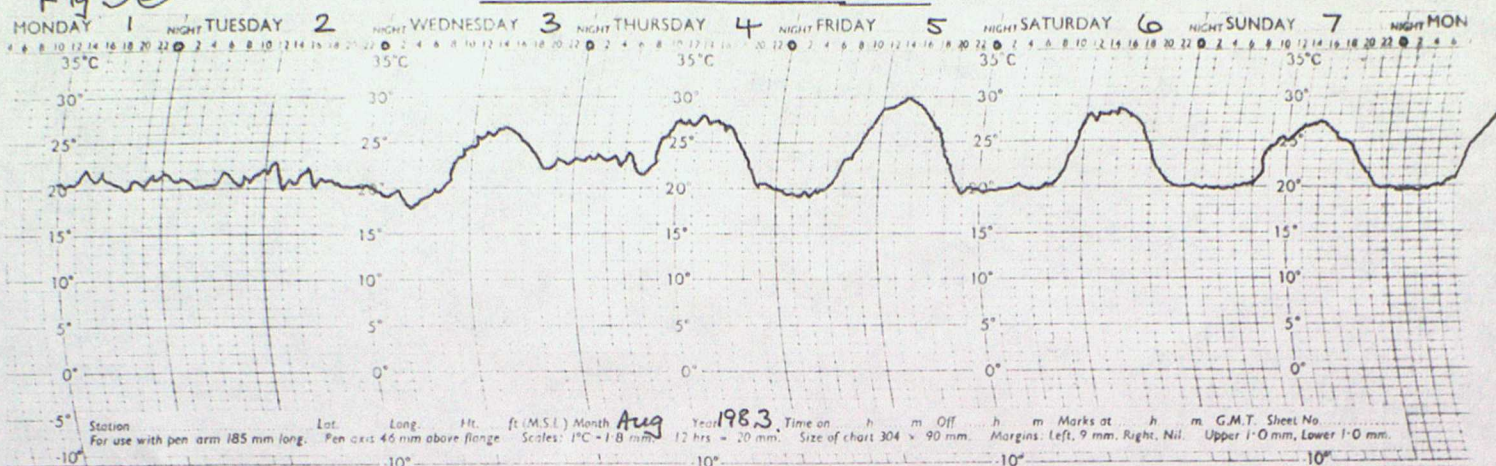


Fig 3f

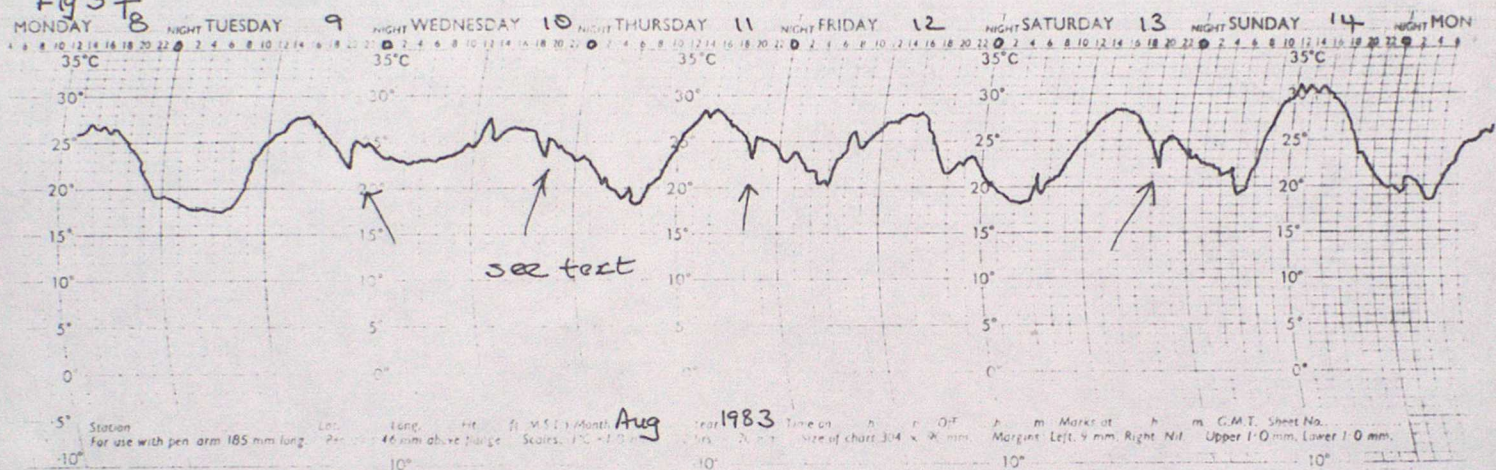


Fig 3g

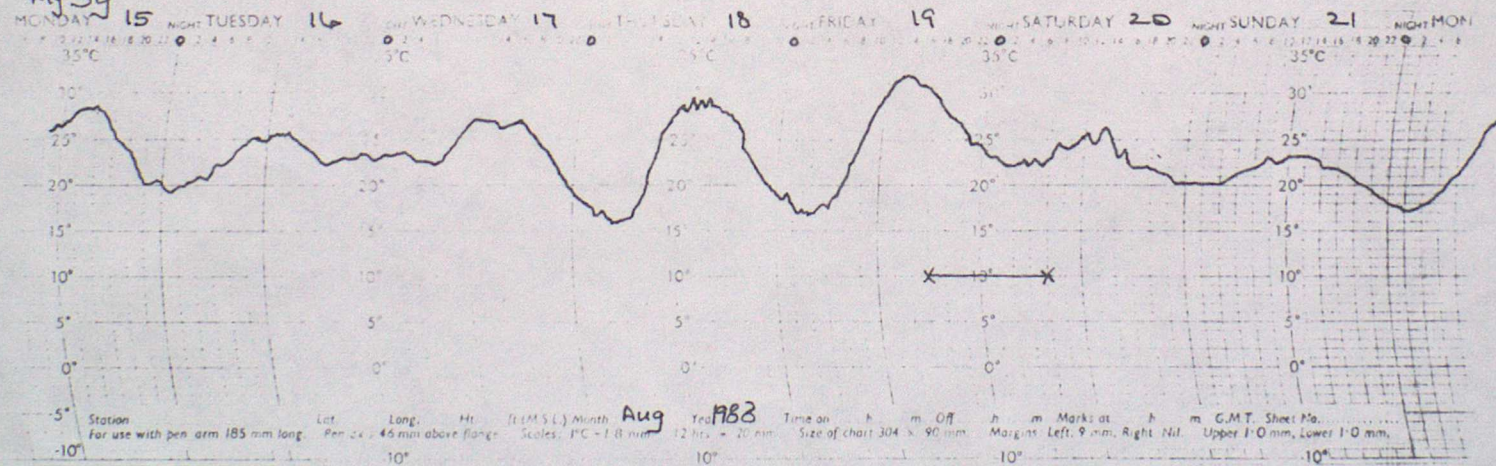


Fig 3h.

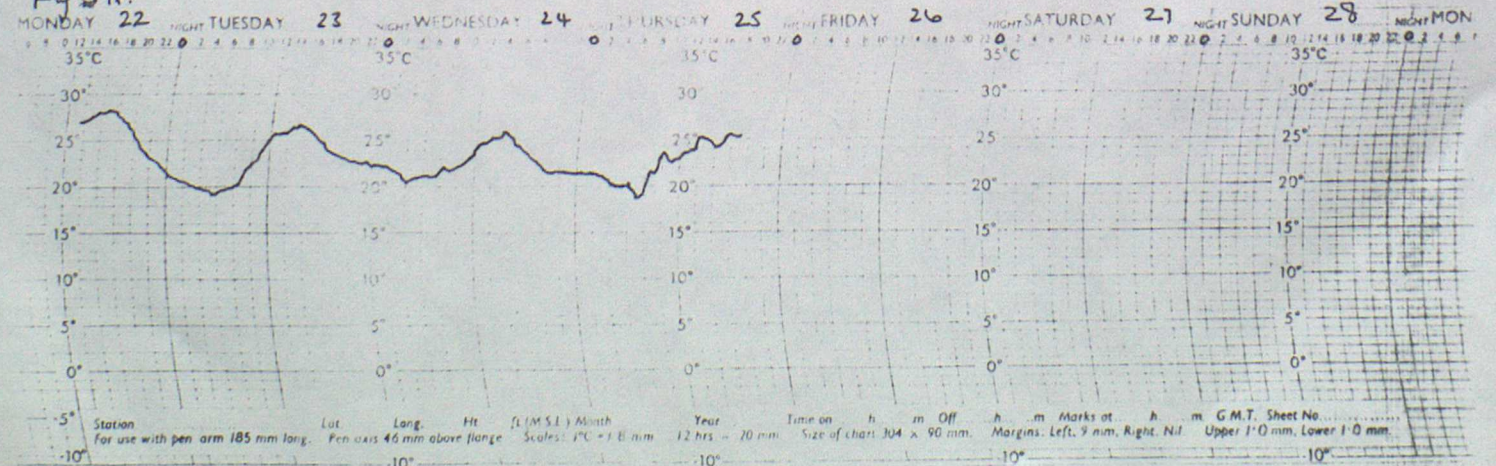


Fig 4a

INTERNAL RELATIVE HUMIDITY

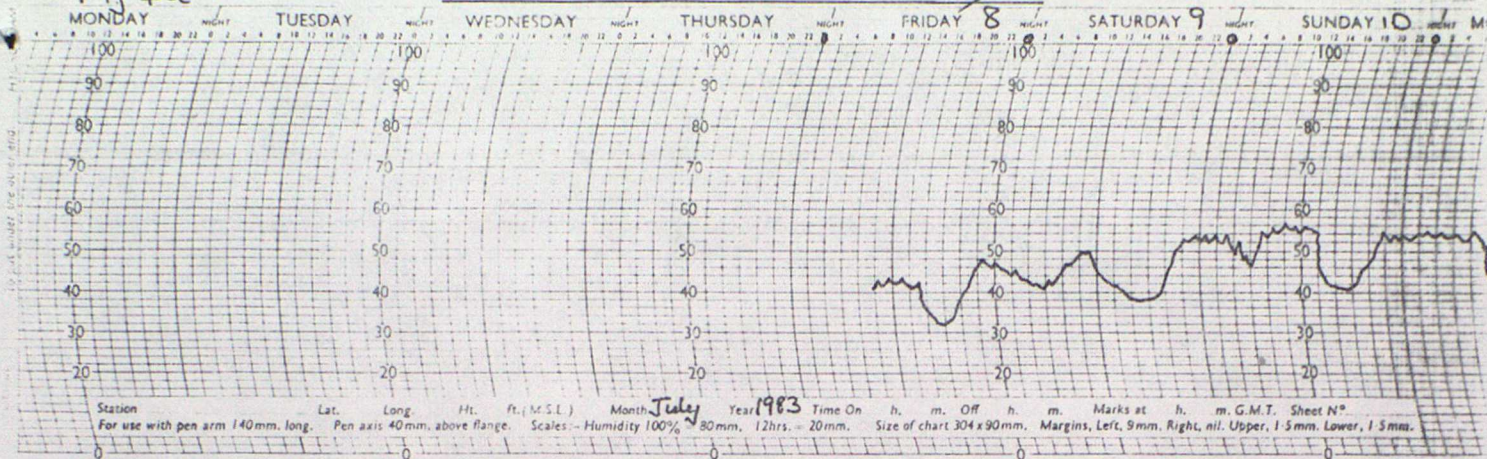


Fig 4b

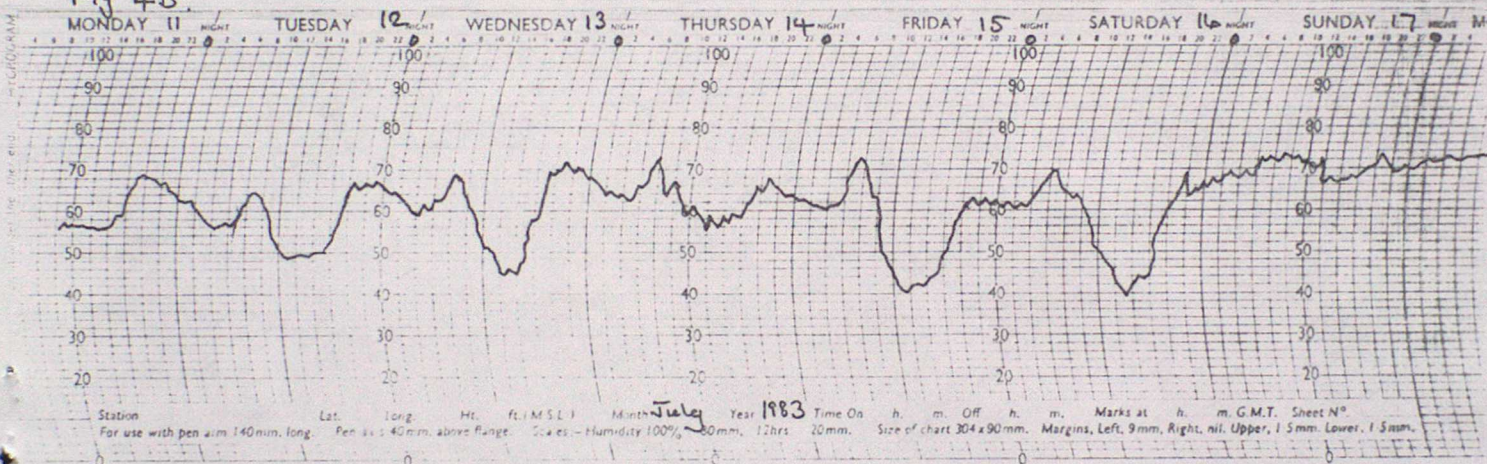


Fig 4c

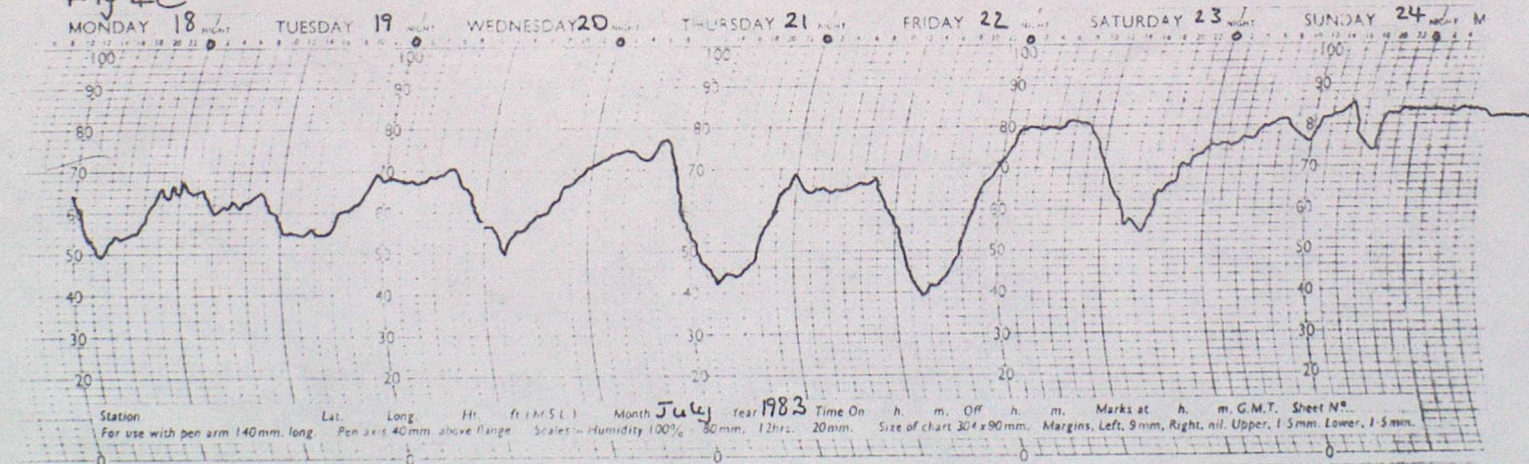


Fig 4d

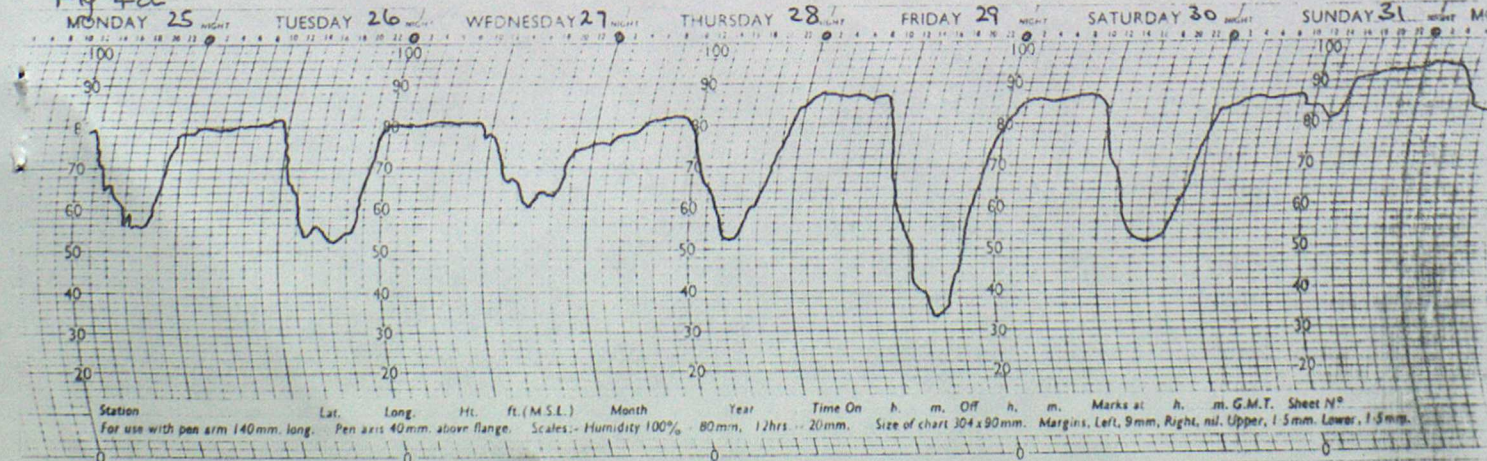


Fig 4e

INTERNAL RELATIVE HUMIDITY

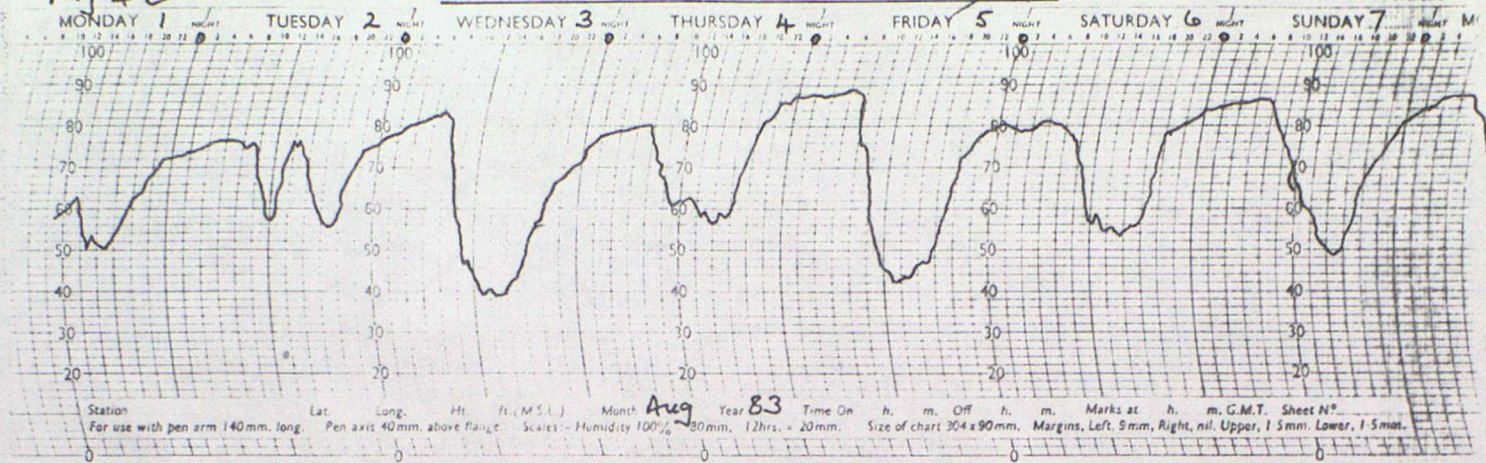


Fig 4f

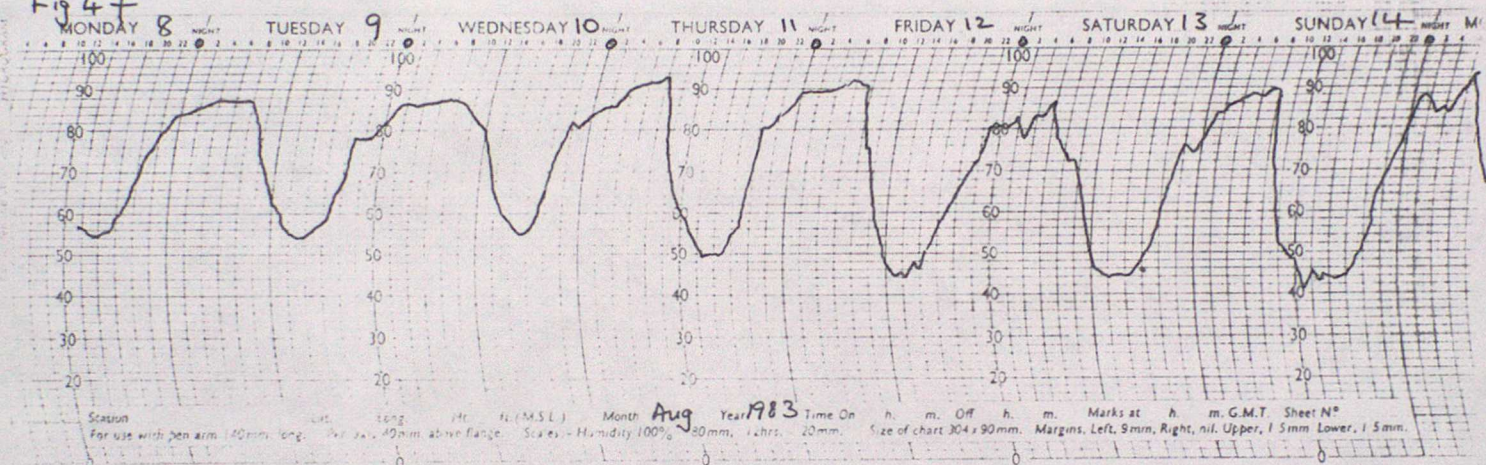


Fig 4g

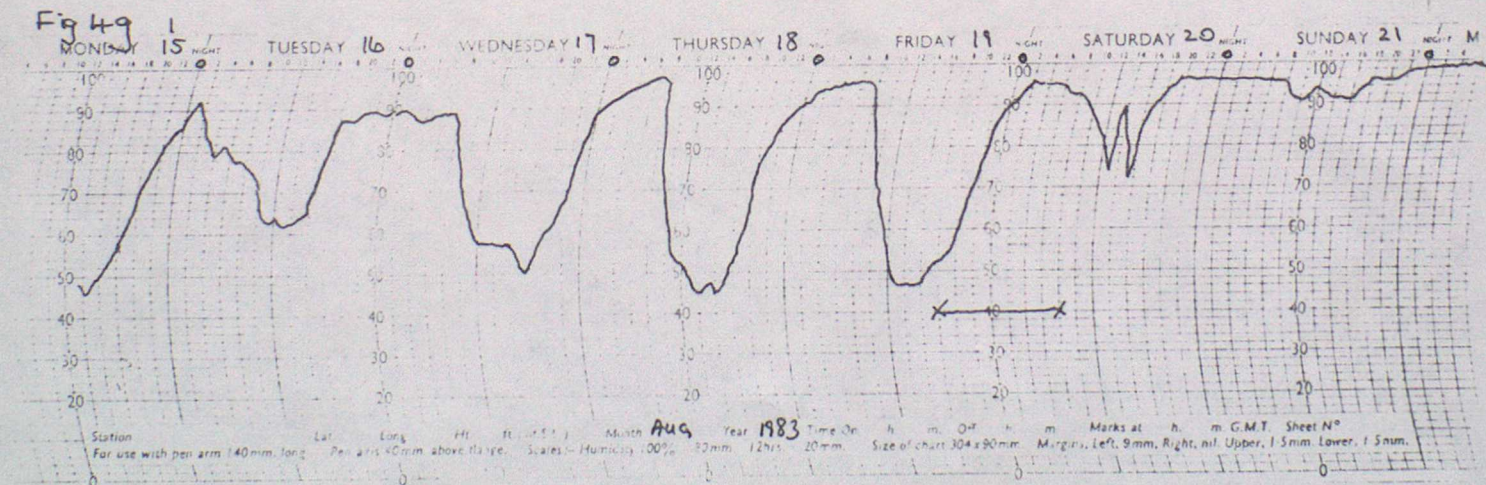


Fig 4h

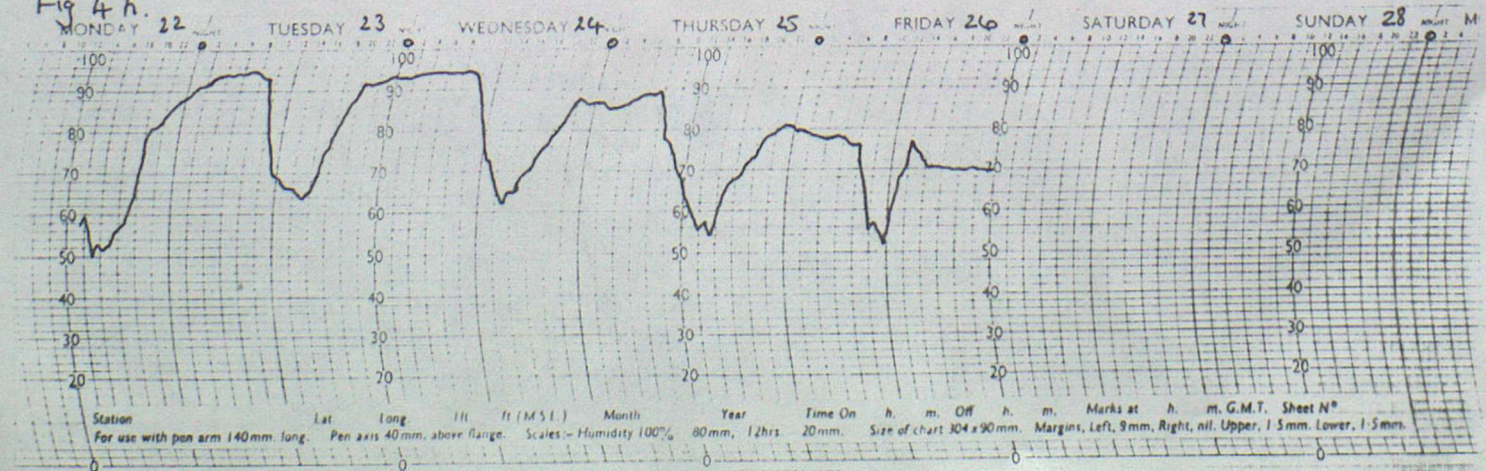


Fig 5a

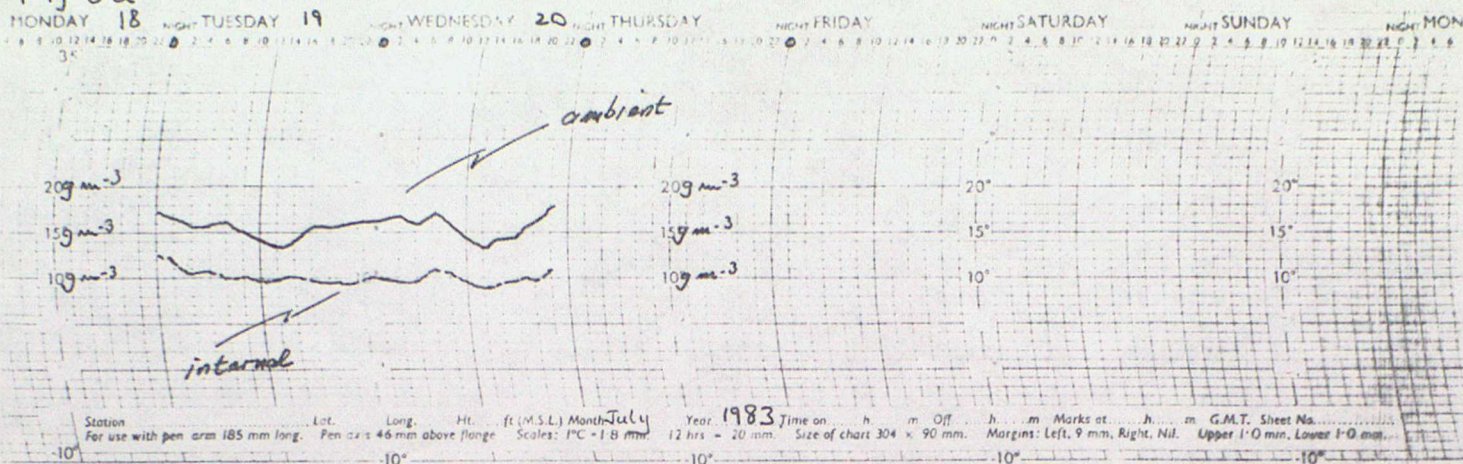
MOISTURE CONTENT OF AIR. (gm^{-3})

Fig 5 b.

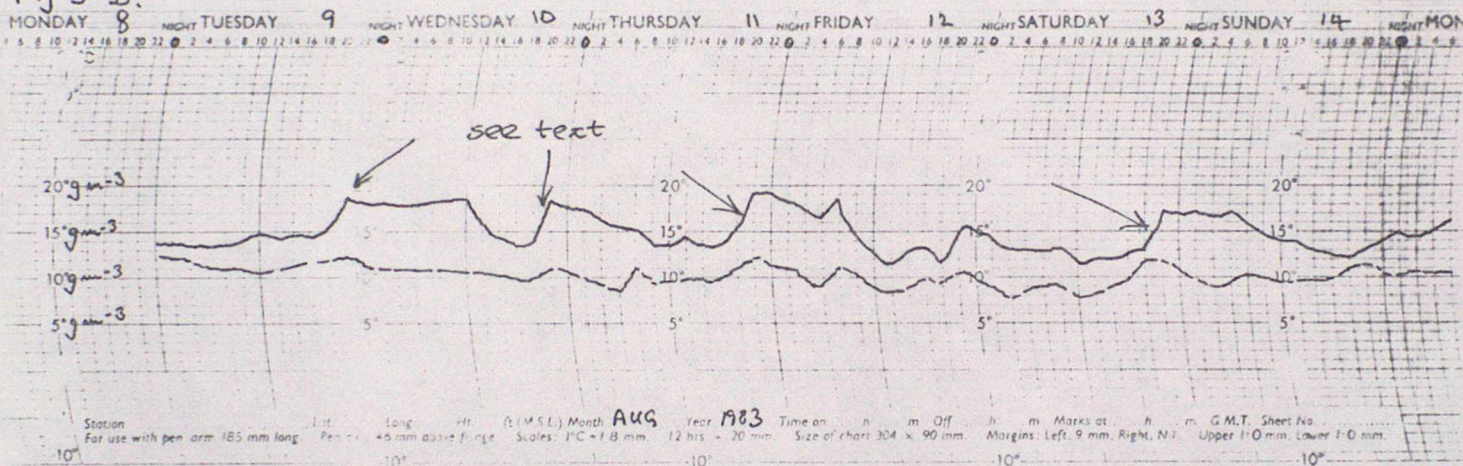


Fig 5 c.

